

SPIDER (ARANEAE) TAXA ASSOCIATED WITH THE IMMATURE STAGES OF *MANTISPA INTERRUPTA* (NEUROPTERA: MANTISPIDAE)^{1,2}

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ABSTRACT: The immature stages of *Mantispa interrupta* are associated with 10 species of spiders, not previously recorded as hosts, from the families Gnaphosidae, Lycosidae, Ctenidae, and Pisauridae. First-instar mantispids were found on adult and juvenile spiders of both genders, while later-instar mantispids were located inside spider egg sacs. Larvae on spiders were located on the edge of the carapace, on the dorsal, ventral, and lateral surfaces of the pedicel, and inside book lungs. The locations on spiders occupied by *M. interrupta* first instars are compared with those occupied by first instars of other mantispine species.

Adult Mantispinae have been reared exclusively from spider egg sacs (Redborg and MacLeod 1985, Brushwein 1986, Hoffman and Brushwein 1989). Mantispine larvae develop through three instars by feeding on spider eggs. Pupation occurs within the egg sac and pharate adults exit both their own cocoons and the spider egg sacs before adult eclosion occurs. First instars procure spider eggs either by locating and entering preexisting egg sacs or by locating and boarding female spiders and subsequently entering egg sacs as they are deposited by the spiders. Recent studies on the spiders associated with particular mantispine species suggest that these associations may be indicative of the egg procurement methods used by first instars of those mantispine species (Redborg and MacLeod 1985, Hoffman and Brushwein 1989).

Mantispa interrupta Say has been recorded throughout the eastern United States and westward into Texas and Arizona (Throne 1972), and adults have been reared from the egg sacs of three spider species. Smith (1934) reported the emergence of two pupae from two spider egg sacs, one of which was associated with a female *Eris militaris* (Hentz) [as *Philaeus militaris* (Hentz)]. Subsequently, adult emergence has been reported from egg sacs of *Gnaphosa muscorum* (L. Koch) and *Lycosa rabida* Walckenaer (Kaston 1940, Rice 1985). In addition to the above records, *M. interrupta* has been incorrectly reported as being associated with two other spider species, but both associations were actually based on species other than *M. interrupta*. Eason *et al.* (1967) associated *M. interrupta* with *Philodromus aureolus* (Clerck) and attributed the association to Auten

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(1925). However, Auten (1925) reported on the chrysopterid *Chrysopa interrupta* Schneider, not *M. interrupta*. Killebrew (1982) reported that a mantispid which emerged from an egg sac of *Peuceetia viridans* (Hentz) was possibly *M. interrupta*. However, this specimen was recently examined by one of us (KMH) and proved to be a pharate adult of *Mantispa sayi* Banks.

Viets (1941) supplied the only indication that *M. interrupta* larvae can board spiders in order to procure eggs. The laboratory boarding of an unidentified female lycosid by several first instars was followed by deposition of an egg sac by the spider and subsequent emergence of an adult mantispid. Both Redborg and MacLeod (1985) and Brushwein (1986) reported that *M. interrupta* has been reared using techniques developed for two other mantispine species, but no information on spider associations or boarding was supplied. The present paper reports further spider associations for *M. interrupta*, confirms larval boarding behavior in the field by documenting the presence of larvae on collected spiders, and compares the locations on spiders of *M. interrupta* larvae with those reported for other mantispine species.

METHODS

Eight of the 13 spiders associated with *M. interrupta* were collected in pitfall traps from 12 June to 1 August 1988, four were collected by visual searching, and the remaining association was based on museum specimens. The pitfall traps were located in the Clemson University Experimental Forest surrounding Lake Issaqueena, Pickens County, South Carolina. The traps were constructed of 2 or 3 liter soft drink bottles whose tops were cut off and inverted to form funnels. Holes were punched in the bottoms to aid in water drainage and a few curled leaves were supplied in each trap to provide harborage sites for trapped spiders. Forty-four traps were buried to ground level at six locations within a mixed hardwood-pine forest and checked one to three times each week. The female *Schizocosa saltatrix* (Hentz) and egg sac were collected in the vicinity of Lake Issaqueena on 14 May 1988, while the specimens of *Gladicosa gulosa* (Walckenaer) and *Varacosa avara* (Keyserling) were collected on 24 July 1988 along a tributary of Toxaway Creek at County Road 88, Oconee County, South Carolina. The female *Pisaurina brevipes* (Emerton) and egg sac were collected on 15 November 1988 near Corkscrew, Lee County, Florida. The association of *M. interrupta* with *Sosipus floridanus* Simon was based on specimens located in the entomological collections of the Museum of Comparative Zoology (MCZ), Harvard University. The spider and its egg sac had been collected by P. J.

Cone in Collier County, Florida, at the junction of 840A and 846, approximately 5 miles east of Immokalee. The pharate adult emerged on 16 April 1968, but collection date of the egg sac was unrecorded.

Identities of the immature stages of *M. interrupta* were confirmed by comparisons of first instars with those previously obtained from an adult female and by allowing later instars to complete development within the egg sacs in which they were found. Spider egg sacs were identified by determination of the particular female spider accompanying each sac. The specimen of *V. avara* was reared to maturity in order to facilitate a species-level identification. Spiders were identified both by the use of selected taxonomic references (Brady 1962, 1979, Carico 1972, Platnick and Shadab 1975, Dondale and Redner 1978, Peck 1981, Roth 1985) and with the assistance of A. R. Brady and C. D. Dondale. Voucher specimens of *M. interrupta* first instars, adults, and associated spiders are deposited in the Clemson University Arthropod Collection (CUAC), Department of Entomology.

RESULTS AND DISCUSSION

Eighteen *M. interrupta* immatures were associated with 13 spiders representing ten spider species from the Gnaphosidae, Lycosidae, Ctenidae, and Pisauridae, thereby bringing the total spider taxa associated with *M. interrupta* to 13 species in nine genera from five families (Table 1). These species are predominantly ground-wandering hunters, although both *P. brevipes* and *E. militaris* are somewhat more arboreal wanderers than the others and *S. floridanus* builds funnel webs near ground level.

First instars of *M. interrupta* were associated with adult and juvenile spiders of both genders, whereas later instars were found inside spider egg sacs (Table 1). The locations of first instars aboard spiders included the edge of the carapace, the dorsal, ventral, and lateral surfaces of the pedicel, and the book lungs. Two of the nine spiders boarded by first instars had more than one larva. Larvae on these spiders occupied either different regions of the same structure, e.g., opposite sides of a pedicel, or similar regions of separate structures, e.g., the left and right book lungs. Two first instars were dead when collected; one was found in a book lung along with a live larva and the other was alone in the book lung of a different spider. In the only previous report of *M. interrupta* first instars aboard a spider, Viets (1941) noted that larvae crawled over the body of the spider upon boarding and that the area between and around the spinnerets seemed to be preferred. However, the positions of the several larvae which remained on the spider after 15 days was not mentioned, and it is possible that some larvae resided in locations similar to those

reported above. The presence of first-instar *M. interrupta* on spiders, coupled with the predominantly wandering-mode behavior of the associated spiders, supports the hypothesis of Hoffman and Brushwein (1989) that mantispine species which use spider boarding to gain access to spider eggs will be associated generally with wandering spiders.

Table 1. Spider taxa associated with the immature stages of *Mantispia interrupta*. Superfamilies and families are arranged according to the taxonomic list presented by Shear (1986). (juv. = juvenile).

| SUPERFAMILY | Developmental stage & gender of spider | <i>M. interrupta</i> immatures | | | Reference |
|--|--|--------------------------------|--------|----------------------|-------------|
| Family | | Instar | Number | Location | |
| Species | | | | | |
| CLUBIONOIDEA | | | | | |
| Gnaphosidae | | | | | |
| <i>Gnaphosa fontinalis</i> Keyserling | female | 1 | 1 | pedicel | this report |
| <i>Gnaphosa muscorum</i> (C.L. Koch) | egg sac | pupa? | 1 | egg sac | Kaston 1940 |
| LYCOSOIDEA | | | | | |
| Lycosidae | | | | | |
| <i>Gladicosa gulosa</i> (Walckenaer) | juv. male | 1 | 1 | book lung | this report |
| <i>Lycosa acompa</i> Chamberlin | male | 1 | 1 | book lung | this report |
| <i>Lycosa georgicola</i> Walckenaer | juv. male | 1 | 5 | pedicel & book lungs | this report |
| <i>Lycosa rabida</i> Walckenaer | egg sac | pupa | 1 | egg sac | Rice 1985 |
| <i>Lycosa</i> sp., <i>helluo</i> group | juvenile | 1 | 1 | pedicel | this report |
| <i>Schizocosa ocreata</i> (Hentz) | egg sac | 3 | 1 | egg sac | this report |
| <i>Schizocosa saltatrix</i> (Hentz) | egg sac | 3 | 1 | egg sac | this report |
| <i>Sosippus floridanus</i> Simon | egg sac | ? | 1 | egg sac | this report |
| <i>Varacosa avara</i> (Keyserling) | juv. female | 1 | 1 | carapace | this report |
| undetermined | juvenile | 1 | 1 | pedicel | this report |
| undetermined | juvenile | 1 | 1 | pedicel | this report |
| Ctenidae | | | | | |
| <i>Anahita punctulata</i> (Hentz) | male | 1 | 2 | pedicel | this report |
| Pisauridae | | | | | |
| <i>Pisaurina brevipes</i> (Emerton) | egg sac | pupa | 1 | egg sac | this report |
| SALTICOIDEA | | | | | |
| Salticidae | | | | | |
| <i>Eris militaris</i> (Hentz) | egg sac | pupa | 1 | egg sac | Smith 1934 |

Of the four other mantispine species known to board spiders, only first instars of *M. sayi* [as *Mantispa uhleri* Banks and *Mantispa fuscicornis* Banks, both recently synonymized with *M. sayi* by Hoffman (1989)] occupy a range of resting sites on spiders similar to that of *M. interrupta* first instars (Redborg and MacLeod 1985, Rice 1986). In contrast, first instars of the other three species occupy a more restricted range of sites. First instars of *Climaciella brunnea* (Say) have been found only on the sternum and the edge of the carapace (Redborg and MacLeod 1983, LaSalle 1986), while those of both *Perlamantispa perla* (Pallas) and *Mantispa pulchella* (Banks) occupy only the dorsal surface of the pedicel (Lucchese 1955, 1956, Hoffman and Brushwein 1989).

In previous reports of *M. interrupta* spider associations, the developmental stages of the mantispids at the time of egg sac collection were not known. However, some estimates can now be made by comparing the intervals between egg sac collections and emergences of adult mantispids with the durations of appropriate developmental stages of *M. interrupta* and other North American mantispines. During the present study, the two *M. interrupta* which were reared under ambient conditions from third instars to adult required 17 to 22 days from the onset of cocoon spinning to adult eclosion. Under standard laboratory conditions, *C. brunnea*, *M. sayi*, and *Mantispa viridis* Walker spend an average of 14 to 20 days as prepupae and pupae (Redborg and MacLeod 1983, 1985, Brushwein 1986). Both Smith (1934) and Rice (1985) reported the emergences of adult mantispids within four days of egg sac collections, and therefore these records surely represent field-collected pupae and are listed as such in Table 1. Because of the 17 day lag between egg sac collection and adult emergence, the mantispid collected by Kaston (1940) could have been either a late-instar larva or pupa. Unfortunately, the collection date of the *S. floridanus* egg sac was unrecorded, and therefore the developmental stage of the mantispid when initially collected can not be determined.

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